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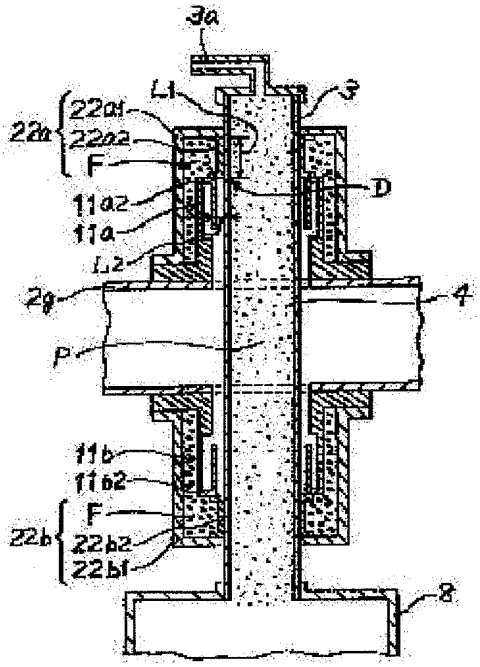
(54) MICROWAVE PLASMA TREATING DEVICE

(57)Abstract:
PURPOSE: To prevent microwave from leaked outside of a plasma treating device by assigning the second cylindrical microwave leakage preventing means consisting of at least a microwave absorbing body at the outside periphery of a plasma transport tube an the opposite side of a rectangular wave guide tube, coaxially with the first microwave leakage preventing means.
CONSTITUTION: As the second microwave leakage preventing means 22a and 22b, fluid microwave absorbing body F is used. Then, the space far accommodating the fluid is assigned on the end face side opposite to a wave guide tube 2g of the first microwave leakage preventing means 11a and 11b. Further, a cylindrical fluid housing member formed at the outside periphery of a plasma transportation tube 3 is assigned outside of the plasma transportation tube, coaxially with the first microwave leakage preventing means 11a and 11b. The fluid housing member forms the common space for the space which houses the microwave absorbing body F and that which houses the cooling media of the microwave leakage preventing means 11a and 11b.



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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The rectangular waveguide which makes microwave spread is made to penetrate the plasma duct which established the processing room in the end. A prevention-of-microwave-leakage means to have the choke structure for microwave arranged in the periphery of the plasma duct of the bond part of said rectangular waveguide and plasma duct is provided. In the microwave plasma treatment equipment made to generate the plasma by microwave in said plasma duct Said prevention-of-microwave-leakage means made into the 1st prevention-of-microwave-leakage means is followed. The 2nd prevention-of-microwave-leakage means which presented tubed and which consists of a microwave absorber at least is arranged on the 1st prevention-of-microwave-leakage means and the same axle at the periphery of said rectangular waveguide and plasma duct by the side of hard flow. Microwave plasma treatment equipment with which the die length by the side of said plasma duct of said microwave absorber was set up more greatly than the gap width of face of said 1st prevention-of-microwave-leakage means and plasma.

[Claim 2] Microwave plasma treatment equipment according to claim 1 with which said 2nd prevention-of-microwave-leakage means consists of fluid stowage material which contains the microwave absorber of the microwave absorber of a fluid, and said fluid.

[Claim 3] Microwave plasma treatment equipment according to claim 2 with which said fluid restoration formation member becomes an inside from the metal which prepared the projection.

[Claim 4] Microwave plasma treatment ****** according to claim 1 which said 2nd prevention-of-microwave-leakage means becomes from a solid microwave absorber.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the microwave plasma treatment equipment which formed still more nearly another prevention-of-microwave-leakage means in a prevention-of-microwave-leakage means to have the choke structure for microwave.
[0002]
[Description of the Prior Art] There are some for which the plasma generated by microwave is used in plasma treatment equipments, such as a CVD system which is one of the equipment which forms a thin film, and an etching system for semi-conductor manufacture. Drawing 4 is the outline block diagram of conventional microwave plasma treatment equipment, and drawing 5 is the outline block diagram showing the important section. The microwave generated with the microwave oscillator 1 is supplied to the plasma generating space 4 in the plasma duct 3 made from a quartz through the waveguide circuit 2 so that it may illustrate. The waveguide circuit 2 is two or more rectangular waveguide 2a -2g. It is constituted. Isolator 2b for protecting an oscillator 1 from a reflected wave in the middle of the waveguide circuit 2 The power monitor 5 which measures an incident wave and a reflected wave, and the impedance matching box 6 which takes adjustment of an impedance in order to transmit power effective in a load are formed.
[0003] The plasma duct 3 is 2g of waveguides of the endmost part of a waveguide circuit. It is prepared in the condition of having penetrated and is 2g of waveguides. The trailer device 7 equipped with the movable shorting bar for adjusting the maximum electric-field location in a waveguide so that it may be in agreement with the location of the plasma duct 3 is formed in the terminal section. In the end of the plasma duct 3, it is gas supply opening 3a. It is prepared, the processing room 8 is established in the other end, the substrate holder 9 is arranged to that interior, and the substrate 10 is held on this holder. Vacuum suction of the inside of the plasma duct 3 and the processing room 8 is carried out by the exhauster which is not illustrated.
[0004] when such equipment performs plasma treatment, while exhausting the inside of the plasma duct 3 -- the gas for processing -- gas supply opening 3a from -- it supplies, and a quantity of gas flow is adjusted so that the inside of the processing room 8 may become predetermined gas pressure. Then, plasma treatment predetermined in a substrate 10 is performed by the plasma which the microwave (2.45GHz) generated with the microwave oscillator 1 was supplied to the plasma generating space 4 in the plasma duct 3, Plasma P generated in this plasma generating space 4, and the plasma diffused in [whole] the plasma duct 3 gradually, and was diffused to the processing room 8.
[0005] Therefore, as shown in drawing 5 , it is 2g of waveguides. In a bond part with the plasma duct 3 In order to prevent leakage of the microwave which spreads a gap with the plasma P generated in 2g 1 or 2g 2 and the plasma generating space 4 of through tubes of a waveguide when Plasma P showed conductive behavior by the TEM mode well-known prevention-of-microwave-leakage means 11a which has the choke structure for microwave, and 11b It is gas supply opening 3a so that the plasma duct 3 may be surrounded, respectively. 2g of waveguides by the side of and and the processing room 8 It is attached and they are this leakage control means 11a and 11b. It consists of the outer case member 11a1 which forms choke structure, 11b1 and a container liner member 11a2, and 11b2. Cylinder-like fluid stowage material 12a which makes the space which contains a cooling medium W form in a periphery in order to cool these prevention-of-microwave-leakage means, and 12b They are prevention-of-microwave-leakage means 11a and 11b, respectively. It is attached outside in the said alignment and made to circulate with the cooling water circulation system which does not illustrate water as a cooling medium.
[0006] However, prevention-of-microwave-leakage means 11a which has the above-mentioned choke structure for microwave If it explains, in a B point, it separates spectrally into an A point side (F1), and the microwave which spread the gap in C point by the TEM mode is spread, and it will separate spectrally into D point side (F2), and it will be spread. Although total reflection is carried out from an A point to a B point in order to connect too hastily in an A point, in a B

point, it separates spectrally into D point side (R1), and the microwave spread to the A point side is spread, and it separates spectrally into C point side (R2), and this reflected wave is spread by it. Therefore, in order to prevent that the microwave by which the above-mentioned spectral separation (F2) and spectral separation (R1) were compounded is revealed out of equipment from D point Fluid stowage material 12a and 12b 2g of the edge by the side of the plasma duct 3 to waveguides So that the periphery of the plasma duct 3 by the side of hard flow may be met Microwave attenuation tubing 13a which has proper die length, and 13b It is prepared, respectively and is made to decrease by making the gap of this attenuation tubing and Plasma P spread by the TEM mode.

[0007]

[Problem(s) to be Solved by the Invention] By the way, it is tended as general needs to avoid enlargement of equipment. Moreover, when there is an order of a miniaturization specification from a user and it makes it correspond to this, it follows on shortening of the above-mentioned plasma duct 3, and they are microwave attenuation tubing 13a and 13b. Since it is shortened In order that the revealed microwave might not fully decline, the microwave will be irradiated by the substrate 10 and there was a problem of doing damage to devices, such as a substrate.

[0008]

[Means for Solving the Problem] In claim 1 of this invention, to the rectangular waveguide which makes microwave spread Make an end penetrate the plasma duct which prepared the processing room, and a prevention-of-microwave-leakage means to have the choke structure for microwave arranged in the periphery of the plasma duct of the bond part of a rectangular waveguide and a plasma duct is provided. The conventional prevention-of-microwave-leakage means for which the microwave plasma treatment equipment made to generate the plasma by microwave is targetted the 1st prevention-of-microwave-leakage means into a plasma duct is followed. The 2nd prevention-of-microwave-leakage means which presented tubed and which consists of a microwave absorber at least is arranged on the 1st prevention-of-microwave-leakage means and the same axle at the periphery of a rectangular waveguide and the plasma duct by the side of hard flow. Die length by the side of said plasma duct of a microwave absorber is characterized by being set up more greatly than the gap width of face of the 1st prevention-of-microwave-leakage means and the plasma.

[0009] Moreover, in claim 2, it is characterized by the 2nd prevention-of-microwave-leakage means consisting of fluid stowage material in which the space filled up with the microwave absorber of the microwave absorber of a fluid and a fluid is made to form.

[0010] Furthermore in claim 3, fluid stowage material is characterized by consisting of metal which prepared the projection in the inside.

[0011] Moreover, in claim 4, it is characterized by the 2nd prevention-of-microwave-leakage means consisting of a solid microwave absorber.

[0012]

[Function] If it is made the configuration indicated to above-mentioned claim 1, it will be prevented that revealing the microwave revealed from the 1st prevention-of-microwave-leakage means which has the choke structure for microwave out of plasma treatment equipment irradiates to the substrate by which is prevented and plasma treatment is moreover carried out.

[0013] If it is made the configuration indicated to claim 2, the microwave revealed from the 1st prevention-of-microwave-leakage means will be absorbed the 1st prevention-of-microwave-leakage means being cooled especially, and, moreover, the structure of the 2nd prevention-of-microwave-leakage means will be simplified.

[0014] If it is made the configuration furthermore indicated to claim 3, absorption to the microwave absorber of the microwave especially revealed from the 1st prevention-of-microwave-leakage means will be performed efficiently.

[0015] Moreover, if it is made the configuration indicated to claim 4, the member which holds especially a microwave absorber will become unnecessary, and anchoring of a microwave absorber will become easy.

[0016]

[Example]

<Example 1> drawing 1 is the outline block diagram showing the important section of the 1st example concerning this invention. It sets to drawing and is 2g. A rectangular waveguide and 3 are a plasma duct and 3a. Gas supply opening and 8 are a processing room, 11a, and 11b. It is a prevention-of-microwave-leakage means to have the choke structure for microwave, and is completely the same as drawing 4 and drawing 5 .

[0017] prevention-of-microwave-leakage means 11a of drawing 5 this example indicates the conventional example to be, and 11b the 1st prevention-of-microwave-leakage means -- carrying out -- 2nd prevention-of-microwave-leakage means 22a and 22b ******, while using the microwave absorber F of a fluid They are 1st prevention-of-microwave-leakage means 11a and 11b about the space which contains this fluid. 2g of waveguides To the end-face side of hard flow And the fluid stowage material of the shape of a cylinder made to form in the periphery of the plasma duct 3 is 1st prevention-of-microwave-leakage means 11a and 11b to the outside of a plasma duct. It is arranged on the same axle.

[0018] 2nd prevention-of-microwave-leakage means 22a and 22b Especially the fluid stowage material to constitute is the space and 1st prevention-of-microwave-leakage means 11a which contain the above-mentioned microwave absorber F, and 11b. In order to make common use space with the space which contains a cooling medium form, it consists of the 1st fluid stowage material 22a1, the 22b1 and 2nd fluid stowage material 22a2, and 22b2. The 1st fluid stowage material 22a1 and 22b1 are fluid stowage material 12a of drawing 5 which shows the conventional example, and 12b. It is 2g of waveguides, respectively. It is made to extend to a hard flow side. In order to make this fluid stowage material 22a1, the container liner member 11a2 which forms 22b1 and choke structure, and 11b2 seal, respectively The 2nd fluid stowage material 22a2 and 22b2 are prepared in the periphery of the plasma duct 3, and this fluid stowage material 22a2 and 22b2 need to be the quality of the materials which penetrate or absorb microwave.

[0019] What is necessary is for the microwave absorption coefficient of this microwave absorber just to determine the dimension of the microwave absorber F suitably. especially -- die length L1 by the side of the plasma duct 3 the gap width of face of the container liner member 11a2, and 11b2 and Plasma P in which it is desirable to shorten for the reason of [having described above] a miniaturization, and it forms choke structure -- L2 ** -- if it carries out -- L1 >L2 it is -- things are desirable. In this case, the microwave after spreading the gap of the above-mentioned container liner member 11a2, and 11b2 and Plasma P by the TEM mode is absorbed, spreading the inside of a microwave absorber. L1 [conversely,] -- < -- L2 it is -- if -- although the microwave which spread the above-mentioned gap is reflected in part at D point shown in drawing, without most is absorbed by the microwave absorber -- the die length L1 of a microwave absorber It will pass through a gap as it is.

[0020] It sets to this example and they are 1st prevention-of-microwave-leakage means 11a and 11b about the microwave absorber F of a fluid. Since it is using also [cooling medium], they are 2nd prevention-of-microwave-leakage means 22a and 22b. It can simplify. In this case, water, alcohol, etc. are illustrated as a microwave absorber. moreover, 1st prevention-of-microwave-leakage means 11a and 11b from -- microwave attenuation tubing 13a shown in the conventional example since the microwave to reveal can be made to absorb with a microwave absorber, and 13b While becoming unnecessary, the plasma duct 3 can be shortened.

[0021] <Example 2> drawing 2 is the outline block diagram showing the important section of the 2nd example concerning this invention. It sets to drawing and is 2g. A rectangular waveguide and 3 are a plasma duct and 3a. Gas supply opening and 8 are a processing room, 21a, and 21b. It is a prevention-of-microwave-leakage means to have the choke structure for microwave, and is completely the same as drawing 4 and drawing 5 .

[0022] Like an example 1, although this example consists of the 1st fluid stowage material 32a1, the 32b1 and 2nd fluid stowage material 32a2, and 32b2, the fluid stowage material which constitutes 2nd prevention-of-microwave-leakage means 32a and 32b This 1st fluid medium formation member 32a1 and 32b1 are conic projection 32c so that it is necessary to be a conductor and may illustrate to that inside. Many are prepared. Moreover, the 2nd fluid stowage material 32a2 and 32b2 need to be the quality of the materials which penetrate or absorb microwave.

[0023] Projection 32c prepared in the 1st fluid stowage material 32a1 and the inside of 32b1 Since it will have the break point of an impedance in the microwave circuit formed in this fluid stowage material 32a1 and the space of 32b1, the microwave revealed in this part is reflected in it.
[0024] the microwave absorber F -- an example 1 -- the same -- die length L1 by the side of the plasma duct 3 of a microwave absorber the container liner member 11a2 which forms choke structure, and gap width of face L2 of 11b2 and Plasma P L1 >L2 it is -- while things are desirable and the microwave after spreading by the TEM mode spreads the inside of a microwave absorber, it absorbs -- having -- and above-mentioned projection 32c It reflects and is absorbed again.
[0025] Projection 32c which reflects the microwave absorber F which makes microwave absorb, and microwave in this example Since it is using together, absorption of microwave becomes efficient. This projection may be other configurations, without being limited in the shape of a cone, and is [0026] which may be beltlike. <Example 3> drawing 3 is the outline block diagram showing the important section of the 3rd example concerning this invention. It sets to drawing and is 2g. A rectangular waveguide and 3 are a plasma duct and 3a. Gas supply opening and 8 are a processing room, 11a, and 11b. The prevention-of-microwave-leakage means and 12a which have the choke structure for microwave, and 12b Fluid stowage material and W are cooling media, and completely the same as drawing 4 and drawing 5 .
[0027] prevention-of-microwave-leakage means 11a of drawing 5 this example indicates the conventional example to be, and 11b the 1st prevention-of-microwave-leakage means -- carrying out -- 2nd prevention-of-microwave-leakage means 42a and 42b ****** -- The microwave absorber S of the solid-state with which the bore was formed in the shape of [of the almost same dimension as the outer diameter of the plasma duct 3] a cylinder They are fluid stowage material 12a and 12b, respectively. 2g of waveguides The end face by the side of hard flow is made to contact, and they are 1st prevention-of-microwave-leakage means 11a and 11b to the periphery of a plasma duct. It is made to arrange on the same axle.
[0028] the microwave absorber S -- an example 1 -- the same -- die length L1 by the side of the plasma duct 3 of a microwave absorber The container liner member 11a2 which forms choke structure, and gap width of face L2 of 11b2 and Plasma P L1 >L2 it is -- things are desirable, and the microwave after spreading by the TEM mode is absorbed, spreading the inside of a microwave absorber.
[0029] In this example, a polyiron, a ferrite, the cement containing graphite, etc. are illustrated as a microwave absorber S. Moreover, what is necessary is for anchoring to become easy and just to bind after anchoring tight from a perimeter, if the microwave absorber is beforehand made into the shape of a half-rate.
[0030]
[Effect of the Invention] As mentioned above, according to invention indicated to claim 1, it can prevent that the microwave revealed from the 1st prevention-of-microwave-leakage means which has the choke structure for microwave irradiates revealing out of plasma treatment equipment to the substrate by which can prevent and plasma treatment is moreover carried out. Moreover, since a plasma duct becomes short while microwave attenuation tubing shown in the conventional example becomes unnecessary, plasma treatment equipment can be miniaturized.
[0031] According to invention indicated to claim 2, the microwave revealed while cooling the 1st prevention-of-microwave-leakage means can be absorbed, and, moreover, the 2nd prevention-of-microwave-leakage means can be simplified.
[0032] According to invention furthermore indicated to claim 3, the microwave revealed from the 1st prevention-of-microwave-leakage means can be made to absorb efficiently to a microwave absorber.
[0033] According to invention indicated to claim 4, the member which holds a microwave absorber becomes unnecessary and, moreover, a microwave absorber can be attached easily.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing the 1st example of the microwave plasma treatment equipment concerning this invention.
[Drawing 2] It is the outline block diagram showing the 2nd example of the microwave plasma treatment equipment concerning this invention.
[Drawing 3] It is the outline block diagram showing the 3rd example of the microwave plasma treatment equipment concerning this invention.
[Drawing 4] It is the outline block diagram showing conventional microwave plasma treatment equipment.
[Drawing 5] It is the outline block diagram showing the important section of drawing 4 .
[Description of Notations]
2g Rectangular waveguide
3 Plasma Duct
8 Processing Room
11a 11b 1st prevention-of-microwave-leakage means
22a 22b, 32a, 32b, 42a, 42b 2nd prevention-of-microwave-leakage means
22a1, 22b1, 22a2, 22b2, 32a1, 32b1, 32a2, 32b2 Fluid stowage material which contains a microwave absorber
32c Projection
F The microwave absorber of a fluid
S A solid microwave absorber

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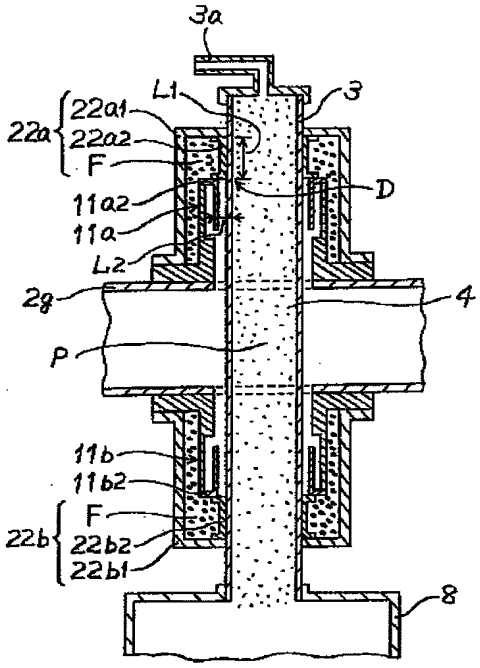
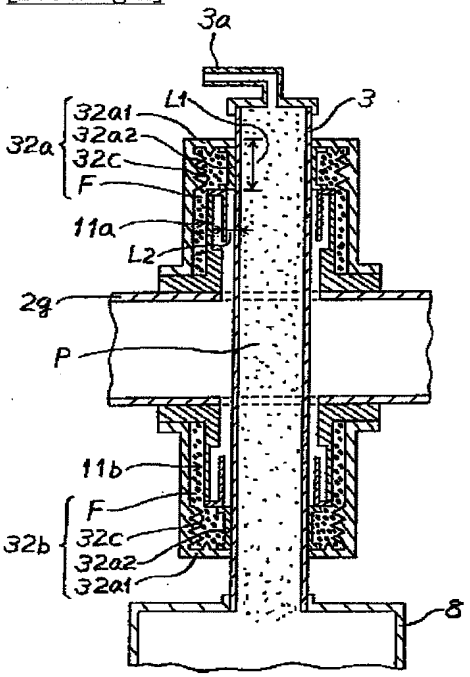
DRAWINGS

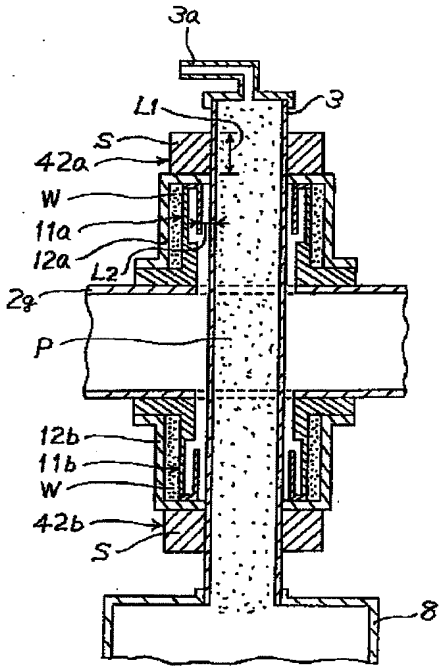
[Drawing 1]



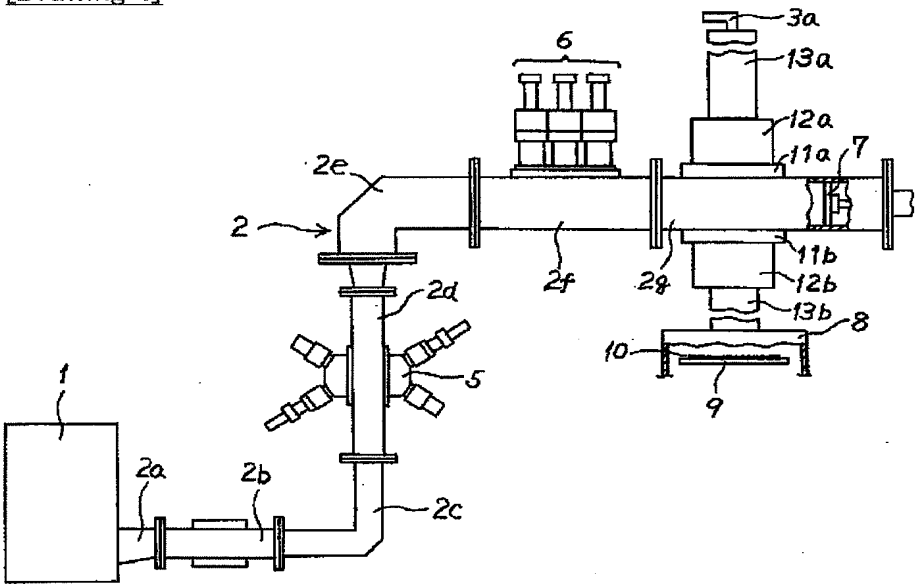
[Drawing 2]



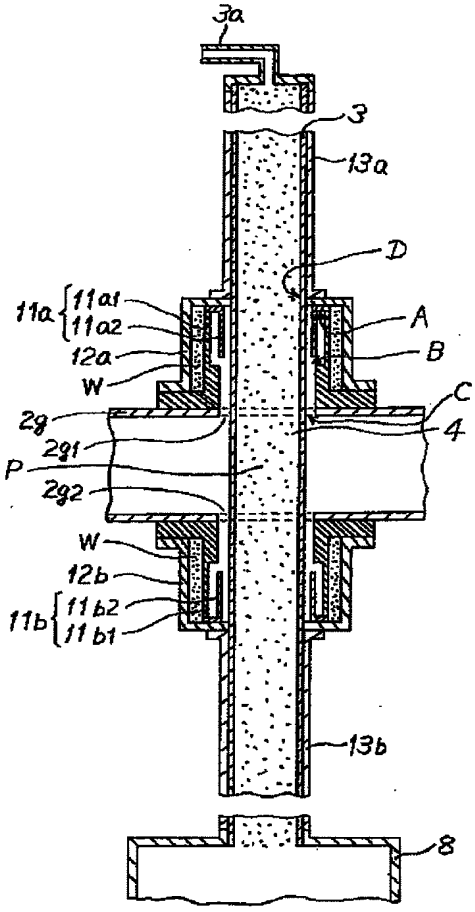
[Drawing 3]



[Drawing 4]



[Drawing 5]



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Ｈ０１Ｆ　30/08				
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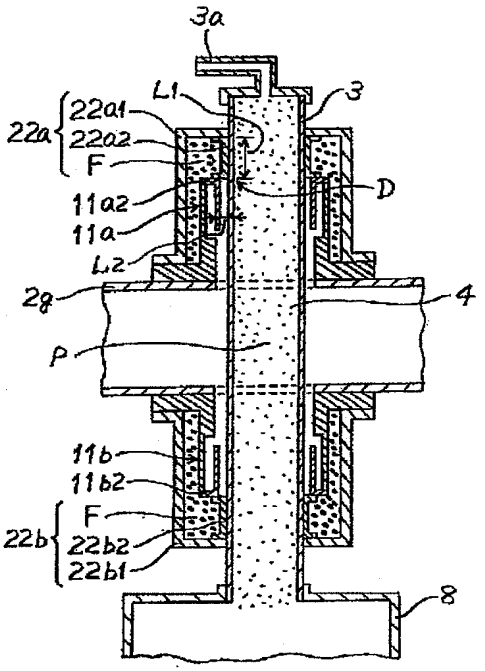
(54)【発明の名称】　マイクロ波プラズマ処理装置

(57)【要約】

【目的】　マイクロ波用チョーク構造を有するマイクロ波漏洩防止手段によるマイクロ波の漏洩を、さらに低減させると共に、マイクロ波プラズマ処理装置の小型化を図る。

【構成】　マイクロ波を伝搬させる方形導波管に、一端に処理室を設けたプラズマ輸送管を貫通させ、方形導波管とプラズマ輸送管との結合部のプラズマ輸送管の外周に配設されたマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段を具備し、プラズマ輸送管内にマイクロ波によるプラズマを発生させるマイクロ波プラズマ処理装置において、第１のマイクロ波漏洩防止手段とするマイクロ波漏洩防止手段と連続して、筒状を呈した少なくともマイクロ波吸収体からなる第２のマイクロ波漏洩防止手段を方形導波管と逆方向側のプラズマ輸送管の外周に第１のマイクロ波漏洩防止手段と同軸上に配設したことを特徴とする。



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【特許請求の範囲】

【請求項1】　マイクロ波を伝搬させる方形導波管に、一端に処理室を設けたプラズマ輸送管を貫通させ、前記方形導波管とプラズマ輸送管との結合部のプラズマ輸送管の外周に配設されたマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段を具備し、前記プラズマ輸送管内にマイクロ波によるプラズマを発生させるマイクロ波プラズマ処理装置において、

第1のマイクロ波漏洩防止手段とする前記マイクロ波漏洩防止手段と連続して、筒状を呈した少なくともマイクロ波吸収体からなる第2のマイクロ波漏洩防止手段を前記方形導波管と逆方向側のプラズマ輸送管の外周に第1のマイクロ波漏洩防止手段と同軸上に配設し、

前記マイクロ波吸収体の前記プラズマ輸送管側の長さが、前記第1のマイクロ波漏洩防止手段とプラズマとの間隙幅より大きく設定されたマイクロ波プラズマ処理装置。

【請求項2】　前記第2のマイクロ波漏洩防止手段が、流体のマイクロ波吸収体と前記流体のマイクロ波吸収体を収納する流体収納部材とからなる請求項1に記載のマイクロ波プラズマ処理装置。

【請求項3】　前記流体充填形成部材が、内面に突起を設けた金属製からなる請求項2に記載のマイクロ波プラズマ処理装置。

【請求項4】　前記第2のマイクロ波漏洩防止手段が、固体のマイクロ波吸収体からなる請求項1に記載のマイクロ波プラズマ処理装置置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、マイクロ波用チョーク構造を有するマイクロ波漏洩防止手段に、さらに別なマイクロ波漏洩防止手段を設けたマイクロ波プラズマ処理装置に関するものである。

【0002】

【従来の技術】薄膜を形成する装置の1つであるＣＶＤ装置や、半導体製造用のエッチング装置等のプラズマ処理装置には、マイクロ波により発生させたプラズマが用いられているものがある。図4は従来のマイクロ波プラズマ処理装置の概略構成図であり、図5はその要部を示す概略構成図である。図示するように、マイクロ波発振器1で発生したマイクロ波は、導波管回路2を介して石英製のプラズマ輸送管3内のプラズマ発生空間4に供給される。導波管回路2は複数の方形導波管2a ～2g により構成されている。導波管回路2の途中には、発振器1を反射波から保護するためのアイソレータ2b と、入射波及び反射波を測定する電力モニター5と、負荷に有効に電力を伝送するためにインピーダンスの整合をとるインピーダンス整合器6とが設けられている。

【0003】プラズマ輸送管3は、導波管回路の最端部の導波管2g を貫通した状態で設けられ、導波管2g の

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端末部には、導波管内の最大電界位置をプラズマ輸送管3の位置に一致するように調整するための可動短絡板を備えた終端部機構7が設けられている。プラズマ輸送管3の一端には、ガス供給口3a が設けられ、他端には処理室8が設けられ、その内部に基板ホルダ9が配置され、このホルダの上に基板10が保持されている。プラズマ輸送管3及び処理室8内は図示しない排気装置により真空引きされるようになっている。

【0004】このような装置によりプラズマ処理を行なう場合、プラズマ輸送管3内を排気しながら処理用ガスをガス供給口3a から供給し、処理室8内が所定のガス圧になるようにガス流量を調整する。その後、マイクロ波発振器1で発生したマイクロ波（2.45GHz ）がプラズマ輸送管3内のプラズマ発生空間4に供給されて、このプラズマ発生空間4内でプラズマＰが発生し、次第にプラズマ輸送管3内の全体にプラズマが拡散され、処理室8まで拡散されたプラズマによって、基板10は所定のプラズマ処理が行われる。

【0005】したがって、図5に示すように、導波管2g とプラズマ輸送管3との結合部には、プラズマＰが導電性の挙動を示すことによって、導波管の貫通孔2g1, 2g2とプラズマ発生空間4内で発生したプラズマＰとの間隙をＴＥＭモードで伝搬するマイクロ波の漏洩を防止するために、マイクロ波用チョーク構造を有する公知のマイクロ波漏洩防止手段11a , 11b が、それぞれプラズマ輸送管3を取囲むようにガス供給口3a 側及び処理室8側の導波管2g に取付けられており、この漏洩防止手段11a , 11b はチョーク構造を形成する外筒部材11a1, 11b1及び内筒部材11a2, 11b2から構成されている。これらのマイクロ波漏洩防止手段を冷却するために、外周に冷却媒体Ｗを収納する空間を形成させる円筒状の流体収納部材12a , 12b が、それぞれマイクロ波漏洩防止手段11a , 11b の外側に同心的に取付けられており、冷却媒体として例えば水を図示しない冷却水循環装置により循環させている。

【0006】しかしながら、上記のマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段11a で説明すると、Ｃ点での間隙をＴＥＭモードで伝搬したマイクロ波は、Ｂ点でＡ点側へ分波（Ｆ1 ）して伝搬され、またＤ点側へ分波（Ｆ2 ）して伝搬される。Ａ点側へ伝搬したマイクロ波は、Ａ点で短絡されるために、Ａ点からＢ点へ全反射するが、この反射波はＢ点でＤ点側へ分波（Ｒ1 ）して伝搬され、またＣ点側へ分波（Ｒ2 ）して伝搬される。したがって、上記分波（Ｆ2 ）と分波（Ｒ1 ）とが合成されたマイクロ波がＤ点から装置外に漏洩することを防止するために、流体収納部材12a , 12b のプラズマ輸送管3側の端部から導波管2g と逆方向側のプラズマ輸送管3の外周に沿うように、適宜の長さを有するマイクロ波減衰管13a , 13b がそれぞれ設けられ、この減衰管とプラズマＰとの間隙をＴＥＭモー

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ドで伝搬させることにより減衰させている。

【0007】

【発明が解決しようとする課題】ところで、一般的なニーズとして装置の大型化を避ける方向にあり、また客先から小型化仕様の注文があり、これに対応させる場合、上記プラズマ輸送管3の短縮化に伴ってマイクロ波減衰管13a，13bも短縮されるので、漏洩したマイクロ波が十分に減衰されないために、そのマイクロ波が基板10に照射されることになり、基板等のデバイスに損傷を与えるという問題があった。

【0008】

【課題を解決するための手段】本発明の請求項1においては、マイクロ波を伝搬させる方形導波管に、一端に処理室を設けたプラズマ輸送管を貫通させ、方形導波管とプラズマ輸送管との結合部のプラズマ輸送管の外周に配設されたマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段を具備し、プラズマ輸送管内にマイクロ波によるプラズマを発生させるマイクロ波プラズマ処理装置を対象とし、第1のマイクロ波漏洩防止手段とする従来のマイクロ波漏洩防止手段と連続して、筒状を呈した少なくともマイクロ波吸収体からなる第2のマイクロ波漏洩防止手段を方形導波管と逆方向側のプラズマ輸送管の外周に第1のマイクロ波漏洩防止手段と同軸上に配設し、マイクロ波吸収体の前記プラズマ輸送管側の長さが、第1のマイクロ波漏洩防止手段とプラズマとの間隙幅より大きく設定されたことを特徴とする。

【0009】また請求項2においては、第2のマイクロ波漏洩防止手段が、流体のマイクロ波吸収体と流体のマイクロ波吸収体を充填する空間を形成させる流体収納部材とからなることを特徴とする。

【0010】さらに請求項3においては、流体収納部材が、内面に突起を設けた金属製からなることを特徴とする。

【0011】また請求項4においては、第2のマイクロ波漏洩防止手段が、固体のマイクロ波吸収体からなることを特徴とする。

【0012】

【作用】上記請求項1に記載した構成にすれば、マイクロ波用チョーク構造を有する第1のマイクロ波漏洩防止手段から漏洩したマイクロ波を、プラズマ処理装置外へ漏洩することが防止され、しかもプラズマ処理される基板へ照射することが防止される。

【0013】また請求項2に記載した構成にすれば、特に第1のマイクロ波漏洩防止手段が冷却されつつ第1のマイクロ波漏洩防止手段から漏洩したマイクロ波が吸収され、しかも第2のマイクロ波漏洩防止手段の構造が簡素化される。

【0014】さらに請求項3に記載した構成にすれば、特に第1のマイクロ波漏洩防止手段から漏洩したマイクロ波のマイクロ波吸収体への吸収が効率的に行われる。

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【0015】また請求項4に記載した構成にすれば、特にマイクロ波吸収体を収容する部材が不要となり、しかもマイクロ波吸収体の取付けが容易となる。

【0016】

【実施例】

＜実施例1＞図1は本発明に係る第1の実施例の要部を示す概略構成図である。図において、2gは方形導波管、3はプラズマ輸送管、3aはガス供給口、8は処理室、11a，11bはマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段であって、図4及び図5と全く同じである。

【0017】本実施例は、従来例を示す図5のマイクロ波漏洩防止手段11a，11bを第1のマイクロ波漏洩防止手段とし、第2のマイクロ波漏洩防止手段22a，22bとして、流体のマイクロ波吸収体Fを用いると共に、この流体を収納する空間を第1のマイクロ波漏洩防止手段11a，11bの導波管2gと逆方向の端面側に、かつプラズマ輸送管3の外周に形成させる円筒状の流体収納部材が、プラズマ輸送管の外側に第1のマイクロ波漏洩防止手段11a，11bと同軸上に配設されたものである。

【0018】第2のマイクロ波漏洩防止手段22a，22bを構成する流体収納部材は、特に上記マイクロ波吸収体Fを収納する空間と第1のマイクロ波漏洩防止手段11a，11bの冷却媒体を収納する空間との共用空間を形成させるために、第1の流体収納部材22a1，22b1と第2の流体収納部材22a2，22b2とから構成されている。第1の流体収納部材22a1，22b1は、従来例を示す図5の流体収納部材12a，12bをそれぞれ導波管2gと逆方向側に延長させており、この流体収納部材22a1，22b1とチョーク構造を形成する内筒部材11a2，11b2とをそれぞれ密閉させるために、プラズマ輸送管3の外周に第2の流体収納部材22a2，22b2を設けており、この流体収納部材22a2，22b2は、マイクロ波を透過または吸収する材質である必要がある。

【0019】マイクロ波吸収体Fの寸法は、このマイクロ波吸収体のマイクロ波吸収率により適宜決定すればよい。特に、プラズマ輸送管3側の長さL1は、上記したように小型化という理由により短くすることが望ましく、チョーク構造を形成する内筒部材11a2，11b2とプラズマPとの間隙幅をL2とすると、L1＞L2であることが好ましい。この場合、上記内筒部材11a2，11b2とプラズマPとの間隙をTEMモードで伝搬した後のマイクロ波は、マイクロ波吸収体内を伝搬しながら吸収される。逆にL1＜L2であれば、上記間隙を伝搬したマイクロ波は図に示したD点で一部反射するが、大半がマイクロ波吸収体に吸収されることなく、マイクロ波吸収体の長さL1の間隙をそのまま通過してしまうことになる。

【0020】本実施例においては、流体のマイクロ波吸

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収体Ｆを第１のマイクロ波漏洩防止手段１１ａ，１１ｂの冷却媒体に兼用しているので、第２のマイクロ波漏洩防止手段２２ａ，２２ｂが簡素化できる。この場合、マイクロ波吸収体としては、水，アルコールなどが例示される。また、第１のマイクロ波漏洩防止手段１１ａ，１１ｂから漏洩するマイクロ波をマイクロ波吸収体により吸収させることができるので、従来例に示すマイクロ波減衰管１３ａ，１３ｂが不要になると共に、プラズマ輸送管３を短くすることができる。

【００２１】＜実施例２＞図２は本発明に係る第２の実施例の要部を示す概略構成図である。図において、２ｇは方形導波管、３はプラズマ輸送管、３ａはガス供給口、８は処理室、２１ａ，２１ｂはマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段であって、図４及び図５と全く同じである。

【００２２】本実施例は実施例１と同様に、第２のマイクロ波漏洩防止手段３２ａ，３２ｂを構成する流体収納部材が、第１の流体収納部材３２a1，３２b1と第２の流体収納部材３２a2，３２b2とから構成されているが、この第１の流体媒体形成部材３２a1，３２b1は、導体である必要があり、その内面には、図示するように例えば円錐状の突起３２ｃが数多く設けられている。また、第２の流体収納部材３２a2，３２b2は、マイクロ波を透過または吸収する材質である必要がある。

【００２３】第１の流体収納部材３２a1，３２b1の内面に設けた突起３２ｃは、この流体収納部材３２a1，３２b1の空間内に形成されるマイクロ波回路に、インピーダンスの不連続点を有することになるので、この部分で漏洩したマイクロ波が反射される。

【００２４】マイクロ波吸収体Ｆは、実施例１と同様に、マイクロ波吸収体のプラズマ輸送管３側の長さＬ1と、チョーク構造を形成する内筒部材１１a2，１１b2とプラズマＰとの間隙幅Ｌ2とは、Ｌ1＞Ｌ2であることが好ましく、ＴＥＭモードで伝搬した後のマイクロ波は、マイクロ波吸収体内を伝搬しながら吸収され、かつ上記突起３２ｃで反射して再び吸収される。

【００２５】本実施例においては、マイクロ波を吸収させるマイクロ波吸収体Ｆとマイクロ波を反射する突起３２ｃとを併用しているので、マイクロ波の吸収が効率的になる。この突起は円錐状に限定されることなく、他の形状であってもよく、また帯状であってもよい

【００２６】＜実施例３＞図３は本発明に係る第３の実施例の要部を示す概略構成図である。図において、２ｇは方形導波管、３はプラズマ輸送管、３ａはガス供給口、８は処理室、１１ａ，１１ｂはマイクロ波用チョーク構造を有するマイクロ波漏洩防止手段、１２ａ，１２ｂは流体収納部材、Ｗは冷却媒体であって、図４及び図５と全く同じである。

【００２７】本実施例は、従来例を示す図５のマイクロ波漏洩防止手段１１ａ，１１ｂを第１のマイクロ波漏洩

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防止手段とし、第２のマイクロ波漏洩防止手段４２ａ，４２ｂとして、内径がプラズマ輸送管３の外径とほぼ同じ寸法の円筒状に形成された固体のマイクロ波吸収体Ｓを、それぞれ流体収納部材１２ａ，１２ｂの導波管２ｇと逆方向側の端面に当接させ、かつプラズマ輸送管の外周に第１のマイクロ波漏洩防止手段１１ａ，１１ｂと同軸上に配設させたものである。

【００２８】マイクロ波吸収体Ｓは、実施例１と同様に、マイクロ波吸収体のプラズマ輸送管３側の長さＬ1と、チョーク構造を形成する内筒部材１１a2，１１b2とプラズマＰとの間隙幅Ｌ2とは、Ｌ1＞Ｌ2であることが好ましく、ＴＥＭモードで伝搬した後のマイクロ波は、マイクロ波吸収体内を伝搬しながら吸収される。

【００２９】本実施例においては、マイクロ波吸収体Ｓとして、ポリアイアン，フェライト，グラファイトを含むセメントなどが例示される。また、マイクロ波吸収体を予め半割り状にしておけば、取付けが容易となり、取付け後は周囲から締め付けるようにすればよい。

【００３０】

【発明の効果】以上のように、請求項１に記載した発明によれば、マイクロ波用チョーク構造を有する第１のマイクロ波漏洩防止手段から漏洩したマイクロ波が、プラズマ処理装置外へ漏洩することが防止でき、しかもプラズマ処理される基板へ照射することが防止できる。また、従来例に示すマイクロ波減衰管が不要になると共に、プラズマ輸送管が短くなるので、プラズマ処理装置を小型化することができる。

【００３１】また請求項２に記載した発明によれば、第１のマイクロ波漏洩防止手段を冷却しながら漏洩したマイクロ波を吸収することができ、しかも第２のマイクロ波漏洩防止手段が簡素化できる。

【００３２】さらに請求項３に記載した発明によれば、第１のマイクロ波漏洩防止手段から漏洩したマイクロ波をマイクロ波吸収体へ効率的に吸収させることができる。

【００３３】また請求項４に記載した発明によれば、マイクロ波吸収体を収容する部材が不要となり、しかもマイクロ波吸収体を容易に取付けることができる。

【図面の簡単な説明】

【図１】本発明に係るマイクロ波プラズマ処理装置の第１の実施例を示す概略構成図である。

【図２】本発明に係るマイクロ波プラズマ処理装置の第２の実施例を示す概略構成図である。

【図３】本発明に係るマイクロ波プラズマ処理装置の第３の実施例を示す概略構成図である。

【図４】従来のマイクロ波プラズマ処理装置を示す概略構成図である。

【図５】図４の要部を示す概略構成図である。

【符号の説明】

２ｇ　方形導波管

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3　プラズマ輸送管
8　処理室
１１a，１１b　第１のマイクロ波漏洩防止手段
２２a，２２b，３２a，３２b，４２a，４２b　第２のマイクロ波漏洩防止手段
２２a1，２２b1，２２a2，２２b2，３２a1，３２b1，３

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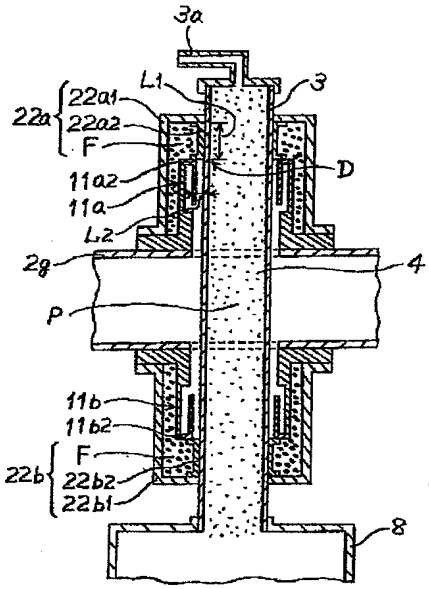
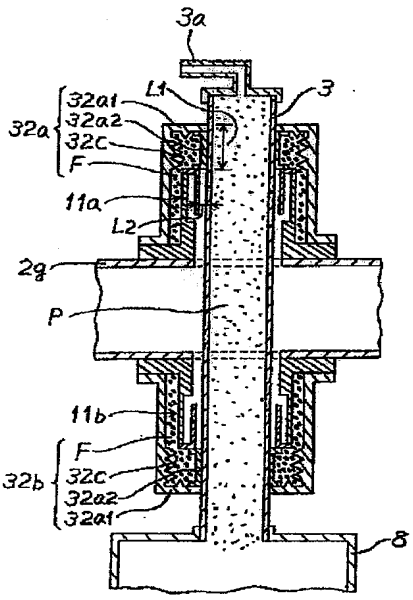
２a2，３２b2　マイクロ波吸収体を収納する流体収納部材
３２c　突起
F　流体のマイクロ波吸収体
S　固体のマイクロ波吸収体

【図１】



【図２】



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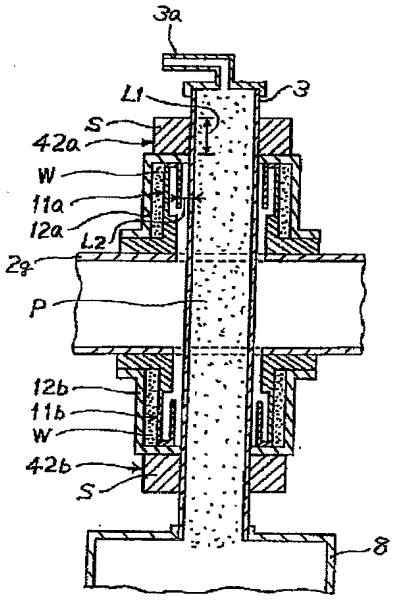

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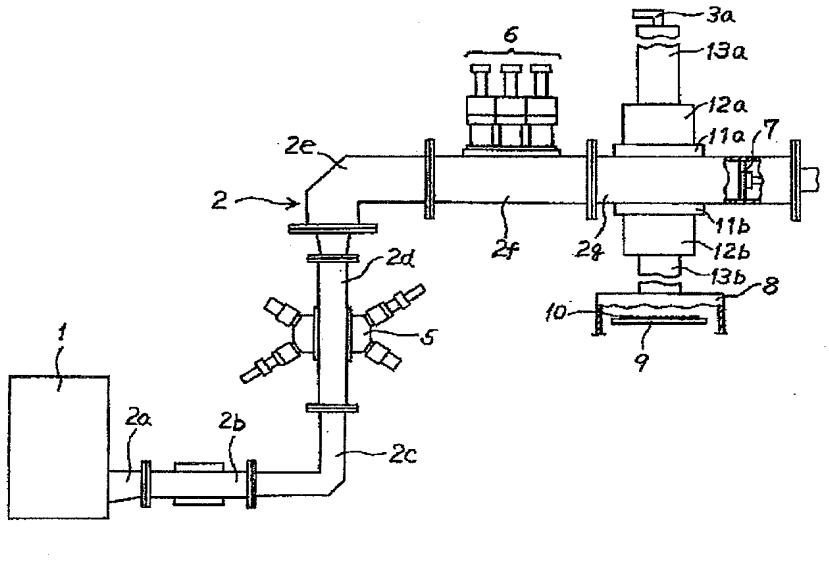
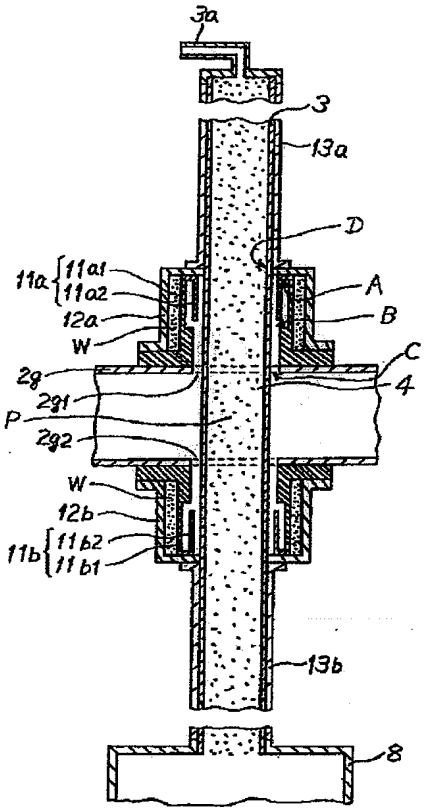


【図5】



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